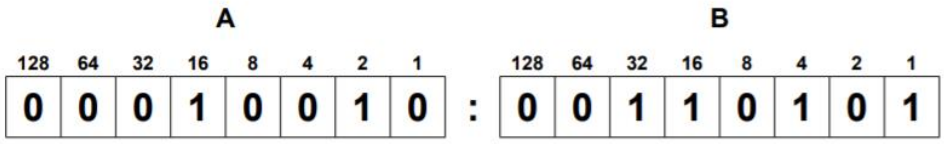
Data Representation

1.1 Number systems

1 An alarm clock is controlled by a microprocessor. It uses the 24 hour clock. The hour is represented by an 8-bit register, **A**, and the number of minutes is represented by another 8-bit register, **B**.

(a) Identify what time is represented by the following two 8-bit registers.

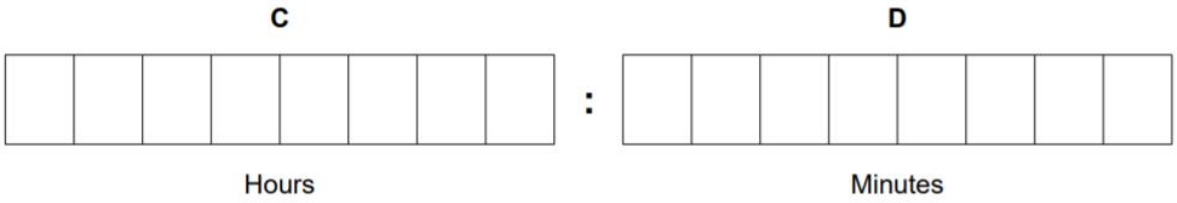


Hours ..... Minutes .....

[2]

(b) An alarm has been set for 07:30. Two 8-bit registers, **C** and **D**, are used to represent the hours and minutes of the alarm time.

Show how 07:30 would be represented by these two registers:



[2]

2 Draw a line to connect each question to the correct answer.

Question	Answer
What is the denary (base 10) equivalent to the hexadecimal digit **E**?	**8**
If 1 GB = 2^X then what is the value of X?	**12**
How many bits are there in one byte?	**14**
If the broadband data download rate is 40 megabits per second, how many seconds will it take to download a 60 MB file?	**19**
What is the denary (base 10) value of the binary number 0 0 1 0 0 1 0 0 ?	**30**
What hexadecimal value is obtained when the two hexadecimal digits **C** and **D** are added together?	**36**

3 Letters from the alphabet are represented in a computer by the following denary (base 10) values:

A = 97
G = 103
I = 105
L = 108
N = 110

The word "**A L I G N**" is stored as: 97 108 105 103 110

(a) Convert each of the five values to binary. The first one has been done for you.

Letter	Denary value							
A (97):	**0**	**1**	**1**	**0**	**0**	**0**	**0**	**1**
L (108):								
I (105):								
G (103):								
N (110):								

[2]

(b) An encryption system works by shifting the binary value for a letter one place to the left. "A" then becomes:

1	**1**	**0**	**0**	**0**	**0**	**1**	**0**

This binary value is then converted to hexadecimal; the hexadecimal value for "A" will be:

C 2

For the two letters "L" and "G", shift the binary values one place to the left and convert these values into hexadecimal:

									hexadecimal
L:									.....
G:									.....

[4]

4 **(a)** Convert the hexadecimal number **B5** into binary:

.....

Convert the binary number **1 1 1 1 0 1 1 0** into hexadecimal:

.....

[2]

(b) Give **two** examples where hexadecimal numbers are used in computer science.

1 .....

.....

2 .....

.....

[2]

(c) State **two** benefits of using hexadecimal numbers in computer science.

1 .....

.....

2 .....

.....

[2]

5 Characters can be represented in a computer by a numerical code.

The following list shows 16 characters with their numerical codes in denary:

a = 97	e = 101	k = 107	t = 116
b = 98	g = 103	m = 109	u = 117
c = 99	h = 104	o = 111	w = 119
d = 100	i = 105	r = 114	

. = 46 (code for the full stop)

Web addresses can be written using hexadecimal rather than denary. Hexadecimal codes are preceded by a % sign. For example, the word "**c a g e**" is written as:

either	99	97	103	101	(in denary)
or	%63	%61	%67	%65	(in hexadecimal)

(a) Complete the conversion of the following web address into hexadecimal:

w	**w**	**w**	**.**	**c**	**i**	**e**	**.**	**o**	**r**	**g**	**.**	**u**	**k**
%77	%77	%77											

[3]

(b) Complete the web address from the given hexadecimal codes:

%77	**%77**	**%77**	**%2E**	**%72**	**%6F**	**%63**	**%6B**	**%69**	**%63**	**%74**	**%2E**	**%63**	**%6F**	**%6D**
W	W	W												

[3]

6 **(a)** **(i)** Convert the following **two** hexadecimal numbers into binary:

F A 7
D 3 E

F A 7 ☐☐☐☐ ☐☐☐☐ ☐☐☐☐

D 3 E ☐☐☐☐ ☐☐☐☐ ☐☐☐☐

[4]

(ii) Now perform the AND (logic) operation on each corresponding pair of binary bits in the two numbers from **part (i)**.

☐☐☐☐ ☐☐☐☐ ☐☐☐☐

[2]

(iii) Convert your answer in **part (ii)** into hexadecimal.

.....

.....

[2]

(b) **(i)** The following code shows HTML 'tag' pairs on either side of the text stating the colour that each creates.

```
<font color " # F F 0 0 0 0 " > RED </font>
<font color " # 0 0 F F 0 0 " > GREEN </font>
<font color " # 0 0 0 0 F F " > BLUE </font>

<font color " #      X      " > YELLOW </font>
<font color " #      Y      " > MAGENTA </font>
<font color " #      Z      " > CYAN </font>
```

Yellow is a combination of red and green, magenta a combination of red and blue and cyan a combination of green and blue.

State what 6-digit hexadecimal values should replace X, Y and Z in the above code.

X .....

Y .....

Z .....

[3]

(ii) Describe how other colours, such as a darker shade of blue, are created.

.....

.....

(c) 1A – 16 – C5 – 22 – FF – FF is an example of a MAC address.

(i) Identify what the first six and last six hexadecimal digits represent.

First six digits .....

.....

.....

Last six digits .....

.....

.....

[2]

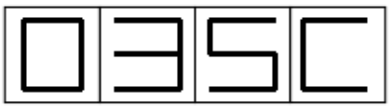
(ii) State why MAC addresses are used.

.....

.....

[1]

7 Each seat on a flight is uniquely identified on an LCD above the seat. For example, seat 035C is shown as:



The first three characters are digits that represent the row.
The fourth character is the seat position in that row. This is a single letter, A to F, that is stored as a hexadecimal value.

Each of the four display characters can be stored in a 4-bit register. For example, 0 and C would be represented as:

	8	4	2	1
0:	0	0	0	0
C:	1	1	0	0

(a) Show how the 4-bit registers would store the remaining two characters, 3 and 5.

3

5

[2]

(b) Identify which seat is stored in the following 4-bit registers.

0	0	0	1	→ .....
1	0	0	1	→ .....
0	1	0	0	→ .....
1	1	1	0	→ .....

[2]

8 **(a)** Convert the following hexadecimal number into 12-bit binary:

4 A F

[3]

(b) The 2016 Olympic Games will be held in Rio de Janeiro. A timer that counts down to the opening of the Games is shown on a microprocessor-controlled display.

The number of hours, minutes and seconds until the Games open are held in three 8-bit registers.

The present register values are:

0	1	1	0	1	0	0	1	105 hours
0	0	1	0	0	0	0	0	32 minutes
0	0	0	1	0	1	0	0	20 seconds

The timer will count **down** in seconds.

(i) Show the values in each 8-bit register **30 seconds** after the time shown above:

								hours
								minutes
								seconds

[3]

(ii) Write the hexadecimal value of the **minutes** register from **part (b)(i)**.

.....[1]

9 The memory of a computer contains data and instructions in binary.

The following instruction is stored in a location of the memory.

0	0	1	0	1	0	0	1	1	1	1	1	1	1	0	0

(a) Convert the instruction into hexadecimal.

.....

.....

..... [2]

(b) Explain why a programmer might prefer to read the instruction in hexadecimal rather than in binary.

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..... [2]

(c) Give **two** other uses of hexadecimal.

Use 1 .....

.....

Use 2 .....

.....

[2]

10 **(a)** The denary number 57 is to be stored in two different computer registers.

Convert 57 from denary to binary and show your working.

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.....[2]

(b) Show the binary number from **part (a)** as it would be stored in the following registers.

[2]

(c) A binary number stored in a register can have many different uses, for example an address in main memory.

Give **two** other uses for a binary number stored in a register.

Use 1 .....

Use 2 .....

[2]

(d) A register in a computer contains binary digits.

0	**0**	**1**	**1**	**1**	**0**	**1**	**0**

The contents of the register represent a binary integer.

Convert the binary integer to hexadecimal.

.....

.....[1]

11 A washing machine has a small display screen built into it.

One use of the display screen is to show an error code when a problem has occurred with a washing cycle.

(a) State whether the display screen is an **input**, **output** or **storage device**.

.....[1]

(b) The display screen shows a hexadecimal error code:

E04

This error code means that the water will not empty out of the washing machine.

Convert this error code to binary.

[3]

(c) State why hexadecimal is used to display the error code.

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.....

.....

.....[1]

(d) Identify **three** sensors that could be used in the washing machine.

State what each sensor could be used for.

Sensor 1 .....

Use .....

.....

Sensor 2 .....

Use .....

.....

Sensor 3 .....

Use .....

.....

[6]

12 A robot arm in a factory is programmed to move products.

The binary instructions to operate the robot arm are:

Operation	Binary Instruction
UP	1 1 1 1
DOWN	0 0 0 1
LEFT	1 0 0 1
RIGHT	0 1 1 0
OPEN	1 1 0 0
CLOSE	0 0 1 1

The instructions are entered as hexadecimal values.

An operator enters the values:

9 1 C 3 F

Convert the values and write down the operation (e.g. RIGHT) carried out by the robot arm.

9 .....

1 .....

C .....

3 .....

F .....

[5]

13 **(a)** Explain the differences between the binary number system and the denary number system.

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.....[4]

(b) Explain the process of converting the binary number 1010 into a denary number.

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.....[5]

14 Jane answers an examination question about computers and data correctly.
Six different words or numbers have been removed from her answer.

Complete the sentences in Jane's answer, using the list given. Not all items in the list need to be used.

- 2
- 10
- 16
- analogue
- binary
- denary
- digital
- hexadecimal

As humans, we process ..... data, but a computer cannot process this type of data. For a computer to be able to process data it needs to be converted to ..... data.

As humans, we mostly use a ..... number system;
this is a base ..... number system.

Computers use a ..... number system;
this is a base ..... number system.

[6]

15 Dheeraj identifies **three** hexadecimal numbers.

Write the **denary** number for each of the three hexadecimal numbers:

2A .....

101 .....

21E .....

[3]

Working Space

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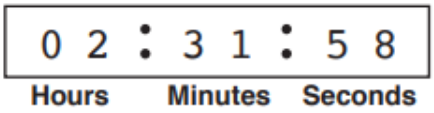
16 A stopwatch uses six digits to display hours, minutes and seconds.

The stopwatch is stopped at:



An 8-bit register is used to store each pair of digits.

(a) Write the 8-bit binary numbers that are currently stored for the **Hours**, **Minutes** and **Seconds**.

Hours								
Minutes								
Seconds								

[3]

(b) The stopwatch is started again and then stopped.

When the watch is stopped, the 8-bit binary registers show:

Hours	0	0	0	0	0	1	0	1
Minutes	0	0	0	1	1	0	1	0
Seconds	0	0	1	1	0	1	1	1

Write the denary values that will now be shown on the stopwatch.

[3]

17 Jafar is using the Internet when he gets the message:

"D03, page is not available"

Jafar remembers that hexadecimal is often used to represent binary values in error codes.

Convert the hexadecimal number in the error message into 12-bit binary.

[3]

18 **(a)** Convert the denary number 107 to binary.

..... [1]

(b) Represent the denary number 300 as it would be stored in a 12-bit binary register.

..... [2]

(c) Convert the denary number 179 to hexadecimal.

..... [2]

19 **(a)** **Six** binary or hexadecimal numbers and **six** denary conversions are given.

Draw a line to connect each binary or hexadecimal number to the correct denary conversion.

Binary or hexadecimal	Denary
01001011	75
4E	78
11011010	157
10011101	167
A7	25
19	218

[5]

(b) Hexadecimal is often used by computer programmers to represent binary values.

Explain why computer programmers may choose to use hexadecimal.

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..... [2]

20 Computers use a character set to convert text into binary.

One character set that can be used is ASCII.

Each letter in ASCII can also be represented as a denary value.

(a) The word BUS has the denary values:

B	U	S
66	85	83

Convert the denary values into 8-bit binary.

66 | | | | | | | | |

85 | | | | | | | | |

83 | | | | | | | | |

[3]

(b) Each letter in ASCII can also be represented as a hexadecimal value.

The word KEY has the 8-bit binary values:

K	E	Y
01001011	01000101	01011001

(i) Convert the three 8-bit binary values into hexadecimal.

01001011 .....

01000101 .....

01011001 .....

[3]

(ii) Give **three** other uses of hexadecimal notation in computer science.

1 .....

2 .....

3 .....

[3]

(iii) State **two** benefits of using hexadecimal notation to represent binary values.

Benefit 1 .....

.....

Benefit 2 .....

.....

[2]

21 The MAC address of a device is represented using hexadecimal.

A section of a MAC address is shown. Each pair of hexadecimal digits is stored using 8-bit binary.

(a) Complete the table to show the 8-bit binary equivalents for the section of MAC address. The first number has already been converted.

6A	FF	08	93
01101010			

[3]

(b) Explain why data is stored as binary in computers.

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.....[2]

22 Hexadecimal is used for MAC addresses.

Part of a MAC address is given:

97 – 5C – E1

Each pair of digits is stored as binary in an 8-bit register.

(a) Show what the binary register stores for each pair of the given digits.

97								
5C								
E1								

[6]

(b) Explain what is meant by a MAC address.

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..... [4]

(c) Give **two** other examples where hexadecimal can be used.

Example 1 .....

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Example 2 .....

.....

[2]

23 Victoria is building a website for her cake design business.

(a) She uses the hexadecimal colour code #D2E3F5 as the background colour for her website.

The colour code is stored in two 12-bit binary registers.

Show how the code would be stored in the registers.

D2E

3F5

[6]

24 An electronic guessing game compares denary integer values input by a user with pre-stored values. The pre-stored values are held in 10-bit binary format.

(a) Convert the binary values in the table to denary.

Binary	Denary
0001001110	
0110110111	
1000000001	

[3]

(b) When planning the game, the designer decided to use hexadecimal notation to represent the binary values.

Explain why the designer used hexadecimal notation.

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.....

.....

..... [2]

(c) State the hexadecimal equivalent of the binary value 1010110101

..... [3]

25 An 8-bit binary register contains the value:

0	0	1	1	0	1	0	0

(a) Convert the binary value to denary.

.....

..... [1]

(b) The contents of the register shifted one place to the right would give the result:

0	0	0	1	1	0	1	0

The contents of the register shown at the start of question 4 are shifted two places to the left.

Show the contents of the register after this shift has taken place.

[1]

(c) State the effect this shift has on the denary value in **part (a)**.

.....

..... [1]

26 **(a)** Give the **denary** value of each of the three 12-bit binary values.

(i) 000000001100

..... [1]

(ii) 000011000110

..... [1]

(iii) 010011000001

..... [1]

Working space

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(b) 12-bit binary values can also be represented as hexadecimal values.

Give the **hexadecimal** value of the 12-bit binary value.

000011101001

..... [3]

27 Pradeep is reading hexadecimal values for a project he is working on.

(a) The first three hexadecimal values he reads are **15**, **102** and **A9**.

Give the **denary** values for the three hexadecimal values.

15 .....

102 .....

A9 .....

[3]

Working space

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(b) Pradeep has two 8-bit binary values that he needs to convert to hexadecimal values for his project.

Give the **hexadecimal** values for the two 8-bit binary values.

01010000 .....

00111101 .....

[4]

28 Ron is attending a music concert. He has bought three tickets.

Each ticket number is displayed as a hexadecimal number.

(a) Complete the table to show the **12-bit binary** values and the **Denary** values for each Hexadecimal ticket number.

Hexadecimal ticket number	12-bit binary value	Denary value
028		
1A9		
20C		

[6]

Working space

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29 **(a)** **Four** denary to 8-bit binary conversions are given.

Tick (✓) to show if each denary to 8-bit binary conversion is **Correct** or **Incorrect**.

Denary	Binary Conversion	Correct (✓)	Incorrect (✓)
145	10010001		
179	10110101		
11	00010011		
100	01100010		

[4]

(b) Convert the **12-bit** binary number into hexadecimal.

1	1	0	0	0	1	0	0	0	0	0	0

..... [3]

30 A denary value can be converted into hexadecimal and binary.

(a) Complete the table to show the hexadecimal and 8-bit binary values of the given denary values.

Denary	Hexadecimal	8-bit binary
49		
123		
200		

[6]

Working space

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.....

(b) Give **two** benefits, to users, of converting binary values to hexadecimal.

Benefit 1 .....

.....

Benefit 2 .....

.....

[2]

(c) Hexadecimal is used to represent Hypertext Markup Language (HTML) colour codes in computer science.

Identify **three** other ways that hexadecimal is used in computer science.

1 .....

2 .....

3 .....

[3]

31 Binary is a number system that is used by computers.

(a) Tick (✓) **one** box to show whether binary is a base-2, base-10 or base-16 number system.

Tick (✓)

☐ Base-2

☐ Base-10

☐ Base-16

[1]

(b) Hexadecimal and denary are number systems that can be used by programmers.

Convert these **four** hexadecimal values into denary values.

09 .....

10 .....

28 .....

A1 .....

[4]

Working space

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32 **(a)** Denary is a number system that is used by programmers.

Tick (✓) **one** box to show whether denary is a base-2, base-10 or base-16 number system.

Tick (✓)	
☐	Base-2
☐	Base-10
☐	Base-16

[1]

(b) Hexadecimal values can be used to represent denary values.

Convert these **four** hexadecimal values into denary values.

05 .....

20 .....

1A .....

AB .....

[4]

Working space

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(c) Hexadecimal values can also be converted to binary values.

Tick (✓) **one** box to show the correct 8-bit binary value for each hexadecimal value.

(i) Hexadecimal value 25

Tick (✓)	
☐	00011001
☐	00100101
☐	10100001

[1]

(ii) Hexadecimal value 1B

Tick (✓)	
☐	00011011
☐	10110001
☐	00011010

[1]

(d) **(i)** Give **one** way that hexadecimal is used in website development.

..... [1]

(ii) Give **one** way that hexadecimal is used in low-level programming.

..... [1]

33 A sports stadium has an electronic counter that counts each person that enters the stadium.

The count is stored as binary in a 16-bit register.

A denary value of the count is displayed on a screen at the entrance.

(a) The screen currently displays:

0	0	7	1

Give the binary value that is stored in the register to display the count shown.

Binary value: .....

Working space

.....

.....

.....

[2]

(b) More people enter the sports stadium and the screen now displays:

0	2	5	7

Give the binary value that is stored in the register to display the count shown.

Binary value: .....

Working space

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[2]

(c) After everyone has entered the stadium, the register stores the binary value:

0000001000000100

Show what the screen will display when this binary value is stored.

Display:

[1]

Working space

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(d) Sensors are used at the entrance to count the number of people entering the stadium.

(i) Identify **two** sensors that could be used to count the number of people entering the stadium.

Sensor 1 .....

Sensor 2 .....

[2]

(ii) Tick (✓) **one** box to show if a sensor is an example of an input device, storage device or output device.

Device	Tick (✓)
input	
storage	
output	

[1]

34 All data needs to be converted to binary data so that it can be processed by a computer.

(a) Explain why a computer can only process binary data.

.....

.....

.....

..... [2]

(b) The denary values 64, 101 and 242 are converted to 8-bit binary values.

Give the 8-bit binary value for each denary value.

64 .....

101 .....

242 .....

[3]

Working space

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(c) The hexadecimal values 42 and CE are converted to binary.

Give the binary value for each hexadecimal value.

42 .....

CE .....

[4]

Working space

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35 **(a)** Denary values are converted to binary values to be processed by a computer.

Draw **one** line from each denary value to the correctly converted 8-bit binary value.

Denary	8-bit binary
	00100001
41	10100110
	00101001
174	10000110
	10101110
86	01010110

[3]

Working space

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(b) Binary values can also be converted to denary values.

Give the correct denary value for the 12-bit binary value 000101010111
Show all your working.

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Denary value .....

[2]

36 Hexadecimal is used for Hypertext Markup Language (HTML) colour codes.

An HTML colour code is:

#2F15D6

Each pair of digits is stored as binary in an 8-bit register.

(a) Give the 8-bit binary value that would be stored for each pair of hexadecimal digits.

2F								
15								
D6								

[6]

Working space

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(b) HTML colour codes and Media Access Control (MAC) addresses are two examples of where hexadecimal is used in Computer Science.

Give **two** other examples of where hexadecimal can be used in Computer Science.

Example 1 .....

Example 2 .....

[2]

37 An aeroplane has a small display screen above each seat, to display the seat number.

(a) The seat number is a hexadecimal value. A 12-bit binary register is used to store the data to display each seat number.

Three seat numbers, 05A, 18C and 29F, are allocated to passengers.

Give the 12-bit binary value that would be stored for each hexadecimal seat number.

05A .....

18C .....

29F .....

[6]

Working space

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(b) The display screen used above each seat is a Light-Emitting Diode (LED) display screen.

Give **two** reasons why an LED display screen has been used.

Reason 1 .....

.....

Reason 2 .....

(c) **Two** of the registers store the values 010000001101 and 000001111110

Give the hexadecimal seat number that would be displayed on the screen for each of these binary values.

010000001101 .....

000001111110 .....

[4]

Working space

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38 Error codes for a computer are often displayed as hexadecimal values. Each error code is stored in a 12-bit binary register.

(a) The error code 404 means 'file not found'.

Give the 12-bit binary value that would be stored for the hexadecimal error code 404

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Working space

.....

.....

.....

[2]

(b) The error code 12B means 'hardware fault'.

Give the 12-bit binary value that would be stored for the hexadecimal error code 12B

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Working space

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[2]

(c) Hexadecimal values can also be represented as denary values.

The hexadecimal error code 022 means 'file system error'. The hexadecimal error code 0AC means 'insufficient memory'.

Convert the hexadecimal error codes 022 and 0AC to denary values.

022 .....

0AC .....

Working space

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[2]

(d) The register stores the binary value 100111100000

Give the hexadecimal error code that would be displayed for the binary value 100111100000

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Working space

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[2]

(e) Give **two** reasons why error codes are represented in hexadecimal, instead of binary.

Reason 1 .....

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Reason 2 .....

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[2]

39 The computer uses 12-bit binary registers to store data whilst it is being processed.

Customers are given a denary ticket number.

(i) Give the 12-bit binary value that is stored in the register for each denary ticket number.

100 .....

235 .....

301 .....

Working space

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(ii) Show the denary ticket number that would be given to the customer for each 12-bit binary value.

000000010110 .....

000001110111 .....

001101011001 .....

Working space

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[3]

(iii) Binary values can also be represented as hexadecimal values.

Show the hexadecimal value that represents each of the **two** 12-bit binary values.

000010010101 .....

101011010001 .....

Working space

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[4]

40 **(a)** Denary values are converted to binary values to be processed by a computer.

Draw **one** line from each denary value to the correctly converted 8-bit binary value.

Denary	8-bit binary
	11110101
72	01110010
	11100101
245	00010101
	00001111
15	01001000

Working space

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[3]

(b) Binary values can be converted to hexadecimal values.

Give the hexadecimal value for the 16-bit binary value 0000100110101110

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Working space

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[3]

41 Binary is a number system used by computers.

(a) Tick (✓) **one** box to show which statement about the binary number system is correct.

A It is a base 1 system ☐

B It is a base 2 system ☐

C It is a base 10 system ☐

D It is a base 16 system ☐

[1]

(b) Denary numbers are converted to binary numbers to be processed by a computer.

Convert these **three** denary numbers to 8-bit binary numbers.

50 .....

102 .....

221 .....

[3]

Working space

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(c) Binary numbers are stored in registers.

Negative denary numbers can be represented as binary using two's complement.

Complete the binary register for the denary number –78

You must show all your working.

Working space .....

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Register:

[2]

(d) Two 8-bit binary numbers are given.

Add the **two** 8-bit binary numbers using binary addition.

Give your answer in binary. Show all your working.

$$\begin{array}{r} 00110011 \\ +\ 01100001 \\ \hline \end{array}$$

[3]

(e) Two binary numbers are added by a computer and an overflow error occurs.

Explain why the overflow error occurred.

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..... [2]

42 Binary numbers can be converted to hexadecimal.

(a) Convert the **two** binary numbers to hexadecimal.

10010011 .....

00001101 .....

[4]

Working space

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(b) A value is stored as a binary number in a register.

0	1	1	1	1	0	1	0

A logical right shift of **three** places is performed on the binary number.

(i) Complete the binary register to show its contents after this logical right shift.

[1]

(ii) State **one** effect this logical shift has on the binary number.

.....

..... [1]

(c) Give **two** reasons why a programmer may use hexadecimal to represent binary numbers.

1 .....

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2 .....

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[2]

(d) Denary numbers can also be converted to hexadecimal.

Convert the denary number to hexadecimal.

301 ..... [2]

Working space

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43 Computers store data as binary. The binary number 10101110 is stored.

(a) Convert the binary number to denary.

..... [1]

Working space

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(b) Convert the binary number to hexadecimal.

..... [2]

Working space

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(c) A logical left shift of **three** places is performed on the binary number.

(i) Give the 8-bit binary number that would be stored after this logical left shift.

..... [1]

(ii) Tick (✓) **one** box to show which statement is true about the impact the logical left binary shift would have on the binary number.

A The least significant bits are lost. ☐

B The most significant bits are lost. ☐

C The number has been divided by six. ☐

D The number stays the same. ☐

[1]

(d) Add the **two** 8-bit binary numbers 11101110 and 00110001 using binary addition.

Give your answer in binary. Show all your working.

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..... [4]

(e) The denary number 301 needs to be stored.

Calculate the least number of bits that can be used to store the denary number 301.

..... [1]

Working space

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(f) The hexadecimal number A4D needs to be stored.

Calculate the least number of bits that can be used to store the hexadecimal number A4D.

..... [1]

Working space

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44 A car park has a payment machine that allows a customer to pay for their parking.

The cost of parking is displayed as a denary number on a screen on the payment machine.

The cost of parking is stored in two 8-bit binary registers.

For the parking cost of $10.50:
- register 1 stores the denary value 10 as binary
- register 2 stores the denary value 50 as binary.

(a) Give the parking cost that would be displayed on the payment machine when the registers store:
- register 1: 00010001
- register 2: 01000110

Parking cost displayed $ ..... [2]

Working space

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(b) The parking cost of $14.98 is displayed on the payment machine.

Give the 8-bit binary numbers that are stored in the registers to display the parking cost.

Register 1 .....

Register 2 .....

[2]

Working space

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(c) The payment machine gives the customer a ticket when they have paid their parking cost. Each ticket has a 4-digit hexadecimal ticket number that is stored as binary.

The binary number 1010000000111101 is stored for a customer's ticket number.

Give the hexadecimal ticket number that would be displayed on this customer's ticket.

Hexadecimal ticket number ..... [4]

Working space

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(d) Explain why data input into the payment machine needs to be converted to binary.

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..... [2]

(e) When a customer is leaving the car park they arrive at a barrier. The customer needs to insert their ticket into a system at the barrier. This system reads the ticket number then checks whether the parking cost has been paid for the car. The barrier is raised if it has been paid.

The system uses a microprocessor.

Describe the role of the microprocessor in the system and how it checks whether the parking cost has been paid.

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..... [4]

45 A register stores the binary number:

1	1	1	0	0	0	1	1

(a) Give the denary number for the binary number stored in the register.

..... [1]

Working space

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(b) Give the hexadecimal number for the binary number stored in the register.

..... [2]

Working space

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(c) A logical left shift of **two** places is performed on the binary number stored in the register.

Complete the binary register to show its contents after this logical left shift.

[1]

(d) The negative denary number −99 needs to be stored in the register.

Complete the register to show the binary number that would be stored, using two's complement. Show all your working.

Working space .....

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Register:

[2]

(e) The number 01001100 is added to 11100011

Add the two 8-bit binary numbers, using binary addition.

Give your answer in binary. Show all your working.

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46 Humans use a denary number system and computers use a binary number system.

(a) Explain what is meant by a binary number system.

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..... [2]

(b) Convert the denary numbers 14, 59 and 234 to binary.

14 .....

59 .....

234 .....

[3]

Working space

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(c) Convert the denary numbers 9, 26 and 65 to hexadecimal.

9 .....

26 .....

65 .....

[3]

Working space

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(d) Convert the positive denary number 123 to 8-bit binary using two's complement.

Show all your working.

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..... [2]

(e) Add the binary values 00110011 and 01111000 using binary addition.

Give your answer in binary. Show all your working.

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..... [3]

47 Hypertext markup language (HTML) colour codes can be represented as hexadecimal.

(a) Tick (✓) **one** box to show which statement about the hexadecimal number system is incorrect.

A It uses the values 0 to 9 and A to F. ☐

B It can be used as a shorter representation of binary. ☐

C It is a base 10 system. ☐

D It can be used to represent error codes. ☐

[1]

(b) Denary numbers can be converted to hexadecimal.

Convert the **three** denary numbers to hexadecimal.

20 .....

32 .....

165 .....

[3]

Working space

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48 The binary number 10100011 is stored in random access memory (RAM).

A logical left shift of **three** places is performed on the binary number.

(a) Give the 8-bit binary number that will be stored after the shift has taken place.

..... [1]

(b) Tick (✓) **one** box to show which statement about a logical left shift of **two** places is correct.

A It would divide the binary number by 2. ☐

B It would multiply the binary number by 2. ☐

C It would divide the binary number by 4. ☐

D It would multiply the binary number by 4. ☐

[1]

(c) 10100011 can be stored as a two's complement integer.

Convert the two's complement integer 10100011 to denary. Show all your working.

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..... [2]

(d) The binary number is measured as a byte because it has 8 bits.

State how many bytes there are in a kibibyte (KiB).

..... [1]

49 Binary is a base 2 number system.

(a) Give the name of the number system that is base 16.

..... [1]

(b) **Three** denary numbers are entered into a computer. The computer converts the numbers and stores them as binary.

(i) Give the binary number that would be stored for each of the denary numbers.

10 .....

50 .....

201 .....

[3]

Working space

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(ii) Explain why the data is converted to binary by the computer.

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..... [2]

(c) The two binary integers 00110000 and 01100110 are added together.

Add the binary integers using binary addition and show your answer in binary. Show all your working.

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..... [3]

(d) The denary integer –32 is stored as a two's complement integer.

Calculate the two's complement integer that would be stored.

Show all your working.

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..... [2]

50 A programmer is creating a computer game. One character is **not** moving correctly.

The programmer needs to debug the program. To do this they need to look at addresses that are locations in memory.

The addresses are displayed as hexadecimal numbers.

(a) One address is A2F.

(i) Convert the address to binary.

..... [3]

(ii) Convert the address to denary.

..... [1]

Working space

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(b) The binary number stored for another address is 000110011011.

(i) Convert the binary number to hexadecimal.

..... [3]

(ii) Convert the binary number to denary.

..... [1]

Working space

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(c) Give **one** reason why the addresses are displayed in hexadecimal instead of binary.

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..... [1]

(d) Identify **two** other ways that hexadecimal is used in computer science.

1 .....

2 .....

[2]

(e) The health value for a character in the computer game can sometimes be a negative value. The negative values are stored as two's complement 8-bit integers.

A character has a health value of –25.

Calculate the two's complement 8-bit integer for –25. Show all your working.

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..... [2]

51 A user enters text into a computer system, using a keyboard.

An American standard code for information interchange (ASCII) character set is used to convert the text to binary.

(a) Identify **one** other character set that could be used to convert the text to binary.

..... [1]

(b) The character 'A' is represented by the denary ASCII number 65.

The character 'm' is represented by the denary ASCII number 109.

(i) Convert the **two** denary ASCII numbers to binary.

65 .....

109 .....

[2]

Working space

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(ii) Convert the **two** denary ASCII numbers to hexadecimal.

65 .....

109 .....

[2]

Working space

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(c) The character 'y' is represented by the binary ASCII number 01111001.

(i) Convert the binary ASCII number to denary.

..... [1]

Working space

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(ii) Convert the binary ASCII number to hexadecimal.

..... [1]

Working space

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(iii) A logical right shift of two places is performed on the binary ASCII number 01111001.

Give the binary number after the logical right shift of **two** places is performed.

..... [1]

Working space

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(d) The character 'T' is represented by the binary ASCII number 01010100.

The character 't' is represented by the binary ASCII number 01110100.

Add the **two** binary numbers using binary addition. Give your answer in binary. Show all your working.

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..... [3]

52 A user enters data that is hexadecimal into a computer system. The data is converted to binary to be processed by the computer.

(a) (i) Give **one** similarity between hexadecimal and binary.

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..... [1]

(ii) Give **two** differences between hexadecimal and binary.

1 .....

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2 .....

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[2]

(b) Data that is denary can also be converted to binary.

Give the binary number for each of the **three** denary numbers.

15 .....

180 .....

235 .....

[3]

Working space

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(c) Denary numbers can also be converted to hexadecimal.

Give the hexadecimal number for each of the **three** denary numbers.

14 .....

100 .....

250 .....

[3]

Working space

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(d) A binary integer that is stored in a register in the computer has a logical left shift performed on it.

(i) Describe the process of the logical left shift that is performed on the binary integer.

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..... [2]

(ii) State what effect this will have on the binary integer.

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..... [1]

(e) A negative binary integer needs to be stored in a register in the computer.

Give the name of the number system that can be used to represent negative binary integers.

..... [1]

53 **(c)** All data is converted to binary to be processed by a computer.

(i) Calculate the binary number for the denary number 175. Show all your working.

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..... [2]

(ii) Give the binary number for the given hexadecimal numbers.

15 .....

2D .....

091 .....

[3]

Working space

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(d) Binary integers can be added together.

Add the **two** binary integers using binary addition. Show all your working. Give your answer in binary.

$$\begin{array}{r} 11100011 \\ +\ 11001100 \\ \hline \end{array}$$

[4]

(e) Calculate the denary number for the two's complement binary integer 10001110. Show all your working.

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..... [2]